

## RACK-AND-PINION STEERING SYSTEM FOR MOTOR VEHICLES

FIELD OF THE INVENTION

The present invention relates to a rack-and-pinion steering system for motor vehicles, the rack of which is mounted in a housing such that it is longitudinally displaceable, is  
5 connected at both ends to in each case one steering rod in an articulated manner, sealing bellows being fastened on one side to the housing and on the other side to the longitudinally displaceable steering rods. The bellows made from a flexible material serve to protect the articulated  
10 connection and the rack against dust, other solid bodies and humidity.

BACKGROUND INFORMATION

During driving operation, what is referred to as a pump  
15 effect occurs on account of the axial displacement movement of the rack, the pump effect widening the bellows as a result of the intake of air but also as a result of temperature-induced air expansion, and therefore subjecting them to an additional load. Secondly, a reduced pressure  
20 compared with atmosphere can occur in the bellows, which can lead to the annular folds bending inwardly. A device for compensation must be provided for the changes in volume occurring in the bellows or also within the housing.

25 German Published Patent Application No. 29 00 026 describes a ventilation apparatus for a shaft joint having bellows sealing, which has a slotted sleeve as a flow connection which is integrated between the shaft and the fastening sleeve of the bellows and allows air to pass. A  
30 disadvantage of such a solution is that, in the event of a wet roadway, water and dirt can penetrate through this

opening into the joint space as a consequence of the proximity of the wheel and heavy occurrence of water spray, and therefore the components to be protected are subjected to increased wear.

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U.S. Patent No. 3,927,576 describes an articulated connection protected by a bellows, in which this disadvantage is eliminated by integrating solids filters in the fastening collar of the bellows or in adjoining regions of, the housing, which filters, in addition to pressure compensation between the interior and atmosphere, also prevent the penetration of moisture and dirt. However, a change to the bellows is necessary here, so that specially manufactured bellows become necessary rather than commercially available ones. The integration of the solid body filter in special ventilation openings of the housing permits subsequent installation into steering systems which are already in service only in conjunction with increased expenditure.

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#### SUMMARY

According to an example embodiment of the present invention, a rack-and-pinion steering system is provided, in which the required pressure compensation between the interior of the bellows or of the steering mechanism housing and atmosphere may be ensured and, independently of the respective deployment situation and loading of the bellows, reliable sealing of the same may be achieved. A pressure compensation element may be integrated in the pressure piece which keeps the rack in constant engagement with the pinion.

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The components to be protected may be reliably sealed using a simple arrangement and with continuous pressure compensation, and the properties of their translational movement may remain preserved without changes to the elastic

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bellows or to the steering mechanism housing becoming necessary.

5 According to an example embodiment of the present invention,  
a rack-and-pinion steering system for motor vehicles  
includes: a pinion; a rack longitudinally displaceably  
arranged in a steering mechanism housing, the rack including  
two ends, each end articulately connected to a respective  
steering tie rod; a pressure piece configured to maintain  
10 the pinion and the rack in constant engagement; a sealing  
bellows fastened on one side to the housing and on another  
side to the steering tie rods; and at least one pressure  
compensation element integrated in the steering mechanism  
housing, the pressure compensation element integrated in the  
15 pressure piece.

According to an example embodiment of the present invention,  
a rack-and-pinion steering system for motor vehicles  
includes: a pinion; a rack longitudinally displaceably  
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two ends, each end articulately connectable to a respective  
steering tie rod; a pressure piece configured to maintain  
the pinion and the rack in constant engagement; a sealing  
bellows fastened on one side to the housing and fastenable  
25 on another side to the steering tie rods; and at least one  
pressure compensation element integrated in the steering  
mechanism housing, the pressure compensation element  
integrated in the pressure piece.

30 According to an example embodiment of the present invention,  
a rack-and-pinion steering system for motor vehicles  
includes: pinion means; rack means longitudinally  
displaceably arranged in a steering mechanism housing means,  
the rack means including two ends, each end articulately  
35 connected to a respective steering tie rod means; means for

maintaining the pinion means and the rack means in constant engagement; sealing bellows means arranged on one side to the housing means and on another side to the steering rod means; and at least one pressure compensating means  
5 integrated in the steering mechanism housing means, the pressure compensating means integrated in the maintaining means.

An exemplary embodiment of the present invention is  
10 illustrated in the appended Figures and explained in the following text in greater detail.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of an electrically assisted power steering system.

5 Fig. 2 is a cross-sectional view of a pressure compensation element integrated in a pressure piece.

## DETAILED DESCRIPTION

10 Although an example embodiment of the present invention is described with reference to a rack-and-pinion steering system 1 having electrical power assistance, it may also be used in rack-and-pinion steering systems 1 having hydraulic power assistance or without power assistance or in steering systems having external power assistance, etc.

15 In a rack-and-pinion steering system 1 of this type, a pinion 9 bears an input shaft 2 which, in the exemplary embodiment illustrated in Fig. 1, is operatively connected to a steering wheel 4 via a steering column 3 provided with universal joints. Together with two steering rods 5 and 6  
20 whose articulated connections to the rack 12 are enclosed in a protective manner by the bellows 19 and 20, the rack of the rack-and-pinion steering system 1 forms on the output element which is operatively connected to wheels which are to be steered. Moreover, the rack 12 forms the driven part  
25 of the steering system. Using a power assisted steering system of this type, it is possible to transmit the steering torque from the steering wheel 4 to the wheels to be steered. An assisting force may be exerted on the input shaft 2 by an electric motor 7. In this exemplary  
30 embodiment, the electric motor 7 is arranged such that its axis is perpendicular with respect to the axis of the input shaft 2 and therefore of the pinion (9). However, it is also possible for its axis to be at a different angle to the

axis of the input shaft 2, for example at an angle of from 60° to 130°.

With an identical or similar effect, the electric motor 7 may be arranged such that its axis is arranged parallel to the axis of the input shaft 2 and therefore of the pinion 9 or parallel to the axis of another part of the steering column 3.

In the two previously described manners of arranging the electric motor 7, the latter acts on the input shaft 2 and the pinion 9 of the rack-and-pinion steering system 1. It is possible for the electric motor 7 to be arranged such that its axis is parallel to, or at an angle to, or coaxially with respect to the axis of the rack 12 of the rack-and-pinion steering system 1.

In the cross-sectional view illustrated in Fig. 2, a pinion 9 is rotatably mounted in two bearings 10 and 11. The toothing of the pinion 9 engages with a rack 12 which is guided in the steering housing 8 in an axially displaceable manner. The rack 12 may be pressed against the toothing of the pinion 9 in a conventional manner using a spring-loaded pressure piece 13.

The rack 12 has a longitudinal groove 16 in its toothing region on the outer circumferential surface on the opposite side from the toothing. The longitudinal groove 16 interacts with a longitudinal lug 17 which is integrally formed on the pressure piece 13. The rack 12 is prevented from tilting during operation by the interaction of the longitudinal groove 16 and the longitudinal lug 17. It is possible for these two elements to be interchanged with an identical effect, so that the longitudinal lug is arranged

on the rack 12 and the longitudinal groove is arranged on the pressure piece 13

5 A pressure compensation element 14 designed to be air and liquid permeable is integrated in the adjusting screw 18 of the pressure piece 13 for pressure compensation in the interior of the mechanism housing 8 of the rack-and-pinion steering system 1. The adjusting screw 18, arranged as a screw cap, serves to adjust the play of the pressure piece, 10 which play may be adjusted by the amount by which the screw cap is screwed in.

For example, the pressure compensation element 14 is configured as a porous sintered plastic insert which is 15 arranged in a cutout 15 of the adjusting screw 18, the cutout 15 being adapted to the dimensions of the sintered plastic insert.

The sintered plastic insert is configured as a pressed 20 pellet composed of PTEE material. Here, the pressed pellet is formed from ground granules which are present, for example, in the form of small balls, the granules being joined to one another under pressure and temperature. The varied density of the sintered material, which may be 25 critical for the air permeability value, may be influenced in a simple manner by the size and/or shape of the granules.

Here, the air permeability of the pressed pellet decreases in a manner corresponding to the magnitude of the applied 30 pressing pressure. The property of the pressed pellet of allowing air to permeate and preventing the penetration of moisture may therefore be determined in a simple manner by the granules or the pressure and the temperature of the sintering process.

The pressure compensation element 14 may also be composed of another sintered material, such as sintered bronze or another moisture tight and air permeable solids filter which may be configured as a thin disk or diaphragm.

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The entire adjusting screw 18 may be composed of porous sintered material.

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The introduction of a pressed pellet into the adjusting screw 18 if the pressure piece 13 may make it simple to retrofit a pressure compensation element 14 to a steering mechanism 18 already in service, by exchanging the existing adjusting screw for one having a pressure compensation element 14.

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